



BALANCE CALIBRATION

Technical Implementing Procedure ID: OSTI-LBNL-TIP/HT-4.0, Rev.0, Mod.0

Effective: 10/04/04

1. PURPOSE

This Technical Implementation Procedure (TIP) describes a method to calibrate laboratory balances at Lawrence Berkeley National Laboratory (LBNL) for supporting the Office of Science and Technology and International (OSTI)-LBNL Project. This procedure is not intended for balance use in the field, where environmental conditions are not well controlled.

2. SCOPE

This procedure applies to calibrations of laboratory balances to be performed by all OSTI-LBNL personnel (or contractor personnel following OSTI-LBNL procedures) involved in laboratory testing for OSTI-LBNL activities subject to the U.S. Department of Energy (DOE) Office of Civilian Radioactive Waste Management (OCRWM) *Quality Assurance Requirements and Description* (QARD), DOE/RW-0333P. This procedure does not apply to OSTI approved contractors on the Qualified Suppliers List (QSL) who provide calibration services using instruments traceable to the National Institute of Standards and Technology (NIST) or other national standards. Prior to conducting work described in Section 3 of this procedure, personnel performing calibrations require training, in accordance with OSTI-LBNL Quality Implementing Procedure (QIP)-2.0, *Indoctrination and Training of Personnel*.

If this procedure cannot be implemented as written, OSTI-LBNL personnel shall notify the responsible Principal Investigator (PI). If it is determined that a portion of the work cannot be accomplished as described in this TIP, or would produce undesirable results, that portion of the work shall be stopped and not resumed until this procedure is modified per OSTI-LBNL-QIP-5.0, *Preparing the Quality Assurance Plan and Quality/Technical Implementing Procedures*.

If the responsible PI determines that a modification or a revision to the TIP would cause an unreasonable delay in proceeding with the task, then an expedited change to the procedure, including documentation of deviation from the approved procedure, can be made according to OSTI-LBNL-QIP-5.0. Such changes are subject to review, usually after the task has proceeded, and thus work performed under TIPs with expedited changes is done at risk of future invalidation.

Scientific staff may use a controlled hard copy or an electronic "Information Only" copy of this procedure (available from the LBNL-ESD website); however, scientific staff are responsible for assuring that the correct revision of this procedure is used. When this procedure becomes obsolete or superseded, controlled copies must be destroyed or marked "superseded", in accordance with OSTI-LBNL-QIP-6.0, *Controlled Documents*, to ensure that this document is not used to perform work.

3. PROCEDURE

3.1 Principle

This TIP describes the detailed steps to calibrate balances internally at LBNL, in accordance with OSTI-LBNL-QIP-12.0, *Control of Measuring and Test Equipment and Calibration Standards*. The objective is to determine functionality and accuracy of balances by recording and comparing balance readings in response to standard weights of known accuracy. Pertinent information from equipment vendor manuals is incorporated into this TIP.

This procedure shall address the following requirements for the balances to be calibrated, per OSTI-LBNL-QIP-12.0:

- A. Identification of standards to be used: see Section 3.4.2.
- B. Detailed description of calibration method: see Section 3.4.
- C. Consideration of manufacturer's recommendations for storage and handling: see Sections 3.2.C and 3.4.1.
- D. Identification of tolerances and ranges of use: see Sections 3.4.4 and 3.4.5.
- E. Identification of calibration intervals: see Section 3.4.7.
- F. Documentation: sufficient documentation shall be recorded in the scientific notebook and the calibration sticker: see Sections 3.4.6 and 3.4.8.
- G. Controls for nonconforming or out-of-tolerance conditions: see Sections 3.4.5 and 3.6.

3.2 Equipment

Standard weights, cotton or equivalent gloves, camel hair brushes and/or lint-free wipe, and padded or non-metal forceps are needed.

A. Equipment Malfunctions

The activities described in this procedure will determine any equipment malfunctions.

B. Safety Considerations

The activities described in this procedure do not require any special safety considerations other than the Environmental Health and Safety (EH&S) requirements that are utilized at LBNL.

C. Special Handling

To avoid scratching, standard weights shall be handled with cotton or equivalent gloves, or padded or non-metallic forceps. Standard weight set storage and access control shall be such as to avoid, to the extent possible, weight set corrosion or damage, and soiling from dust. For example, storage of weights in cases within a controlled cabinet or room should serve this purpose.

3.3 Preparatory Verification

Before using any standard weight(s), the scientific staff member shall inspect them for obvious damage that may be detrimental to balance calibration. Any damaged weight(s) shall be labeled, tagged, or otherwise identified as not useable, in accordance with OSTI-LBNL-QIP-12.0, until their accuracy is verified.

3.4 Calibration Procedure

There are two different tests that are performed as part of the calibration procedure. The first test is an accuracy test, where the accuracy of the balance is verified over a specified calibration range. The second test is a precision test, where measurements of a given weight are repeated to evaluate the precision of the machine. General equipment guidelines and the steps associated with these two calibration tests, to be followed by scientific staff implementing this procedure, are presented below.

3.4.1 Handling of Equipment

Balances shall not be stored and handled in a manner detrimental to their performance. Determine if there are any factors that may be detrimental to good weighing, such as dust, vibration, air drafts, or temperature fluctuation. If a detrimental condition exists, correct it if possible and record actions in the scientific notebook, or if not possible, contact the PI for resolution. Perform a cursory check to observe whether the balance is damaged or in need of repair. If a decision is made to repair or replace the balance, document the decision and action taken in the scientific notebook and issue a Measuring and Test Equipment (M&TE) Out of Calibration Report (OCR), in accordance with OSTI-LBNL-QIP-12.0. The balance shall also have an M&TE Out of Service tag applied and/or be segregated, as described in OSTI-LBNL-QIP-12.0.

3.4.2 Standard Weights

Standard weights used in this procedure shall be American Society for Testing and Materials (ASTM) Class 1 and Class 2 weights. The standard weights must have been calibrated by an OSTI approved, qualified supplier on the OSTI QSL. The calibrated weights should have a certificate documenting their calibration using reference standards traceable to NIST, and that they meet the ASTM Class 1 or Class 2 tolerance requirements. The standard weights shall have an accuracy greater than or equal to that of the balances to be calibrated. It is recommended that standard weight tolerances should not exceed 1/3 of the readability of the balance, but this restriction may not be practical for calibrating low-capacity, high accuracy balances. If standards used have an accuracy equal

to that of the balances, in accordance with OSTI-LBNL-QIP-12.0, document the justification on the M&TE Justification form or in a scientific notebook that includes, as a minimum, the information required by the M&TE Justification form. Visually inspect the standard weights prior to use, and check the calibration sticker to verify that the weight calibration has not expired. The calibration frequency for weights is typically two years. Standard weights should be handled using gloves or forceps to avoid contamination, and should be stored in protective cases that are clearly labeled. Record the unique identifiers of the standard weights and calibration information in the Equipment Logbook or scientific notebook to ensure traceability.

3.4.3 Checks Prior to Weighing

For balances with built-in levels, observe whether the balance is level. If it isn't level, correct with adjusting screws. Use a camel hair brush or lint-free wipe to gently brush away dust and particles, if any, on the weighing pan and surrounding area. If the balance was not in a stand-by condition prior to calibration, power the balance on to allow it to warm up for sufficient time (e.g., 30 minutes, or as suggested by the balance users manual).

3.4.4 Accuracy Test

Construct a table with incremental weight values corresponding to the standard weights available. The accuracy of the balance shall be checked at various weight ranges by choosing at least five increments between these ranges. The ranges are dependent upon balance readability. For example, choose six increments in the range from 0.01 g to 0.1 g, six in the range from 0.1 g to 1 g and so on, up to the limit capacity of the balance, which determines the range of use. If it is desired to calibrate a balance only over a certain range, this may be performed. However, the lower and upper calibration limits shall be stated in the scientific notebook and on the calibration sticker (see Sections 3.4.6 and 3.4.8).

Zero the balance and place the weight or combination of weights on the pan of the balance and wait until the measurement is stable. A 30-second wait is sufficient to ascertain stability and drift. Record this weight. Remove the weight and wait until the balance reading returns to its original zeroed value. Re-zero the balance if necessary. Perform each of the measurements, as specified in the constructed table, in exactly the same manner. The accuracy tolerance should be within the manufacturer's values for the balance, or as defined by the PI. This tolerance should be specified over the range of weights used for each balance in the Equipment Logbook or scientific notebook. Determine if the balance meets the tolerance requirements and record this determination in the Equipment Logbook or scientific notebook. If a balance is found to be out of the allowed specified tolerance, an Out of Service tag shall be applied to the balance to indicate that it is not to be used, in accordance with OSTI-LBNL-QIP-12.0. See Section 3.6 for details on handling out of calibration conditions.

3.4.5 Precision Test

Using selected standard weights (e.g., 0.1 g, 1 g, 10 g, 100 g, 1000 g), perform ten repeated measurements with each weight individually to evaluate the measurement precision and calculate the mean and standard deviation. After completion of the calibration, plot the results and calculate the trend of the balance readings compared to the corresponding standard weights using a linear curve fit algorithm. Indicate also the standard deviation and make a statement regarding the drift, if any. Different balances will have different precisions. The tolerances should be within the manufacturer's recommended repeatability (precision) and linearity specifications for the balance, and/or as defined by the PI. The repeatability and linearity specifications should be specified for each balance in the Equipment Logbook or scientific notebook. Determine if the balance meets the tolerances and record this determination in the Equipment Logbook or scientific notebook. If a balance is found to be out of the allowed specified tolerances, an Out of Service tag shall be applied to the balance to indicate that it is not to be used, in accordance with OSTI-LBNL-QIP-12.0. See Section 3.6 for details on handling out of calibration conditions.

3.4.6 Labeling of Calibrated Balance

For balances within the specified tolerances, prepare a calibration sticker similar to the example given in OSTI-LBNL-QIP-12.0 indicating the unique identifier of the balance (manufacturer, model, serial number), date of the calibration, next calibration date, calibrator's name, and the range of calibration if a particular range has been selected. Attach the sticker to the balance.

3.4.7 Calibration Frequency

Perform the full balance calibration every twelve months or any time when the balance is moved. Conduct a balance performance check every six months by using selected standard weights (e.g., 0.1 g, 1 g, 10 g, 100 g, 1000 g) to determine whether the balance meets the required tolerance. If the performance check shows that the balance reading is out of the allowed specification tolerance, apply an Out of Service tag and conduct the full calibration as specified in Sections 3.4.4 and 3.4.5.

3.4.8 Calibration Documentation

Documentation in the Equipment Logbook or scientific notebook shall include the following information: the unique identification of the balance calibrated; date calibrated; calibration data, recalibration due date; procedure (including revision level) used to calibrate the balance; identification and calibration information of the standard weights used for the balance calibration; range of calibration; results of the calibration and statement of acceptability; as-found condition of the balance, as appropriate; specified range and tolerances and whether the balance meets those tolerances; personnel performing calibrations. The M&TE Calibration Documentation form from OSTI-LBNL-QIP-12.0 may be used for this purpose.

Document each usage of the balance on the M&TE Standard Usage Log from OSTI-LBNL-QIP-12.0, which is filed in the Equipment Logbook, or in the scientific notebook.

3.5 Data Acquisition and Reduction

Data acquisition is done manually by recording the balance readings into the Equipment Logbook or the scientific notebooks according to OSTI-LBNL-QIP-SIII.0, *Scientific Notebooks*. Standard computer software (e.g., Microsoft Excel) may be used to plot the results and to obtain a linear curve fit and standard deviation. No routines or macros shall be used.

3.6 Potential Sources of Error and Uncertainty

Potential sources of error and uncertainty may result from human error in recording or reading the data. Repeating individual measurements is the best way to ascertain that no errors are made. If balances do not hold their calibration throughout the process, they shall be repaired or suspended from usage. According to OSTI-LBNL-QIP-12.0 requirements, the balance shall have an M&TE Out of Service tag applied and/or be segregated. An OCR shall also be prepared and an evaluation of the data collected subsequent to the last calibration or performance check shall be performed. If the evaluation determines that the data are suspect, a Nonconformance Report (NCR) shall be issued in accordance with OSTI-LBNL-QIP-15.0, *Nonconformances*.

3.7 Acceptance Criteria

The ability to calibrate balances within the specified tolerance, affixing a calibration sticker to the calibrated item, and proper completion and filing of the records listed in Section 4.0, constitute the acceptance criteria for this procedure.

4. RECORDS

The records listed below shall be collected and submitted the Records Coordinator for submittal to OCRWM, in accordance with OSTI-LBNL-QIP-17.0, *Records Management*, as individual records or included in a records package.

4.1 Quality Assurance (QA) Records

Records generated as a result of this TIP are entries in:

- Scientific notebooks or attachments to such notebooks
- Equipment Logbooks (including M&TE Justification form, if appropriate, and Standard Usage Log)
- M&TE Out of Calibration Report, if applicable.

4.2 Non-QA Long Term Records

None

4.3 Non-QA Short-Term Records (three years or less retention)

None

5. RESPONSIBILITIES

- 5.1** The **Principal Investigator (PI)** is responsible for assuring full compliance with this procedure and providing training thereof. The PI is responsible for overseeing and coordinating the preparation, review, distribution, revision, and recommending rescission of the TIP.
- 5.2** **Scientific staff** are responsible for following this procedure and turning over related documentation to the Records Coordinator for submittal to OCRWM, in accordance with OSTI-LBNL-QIP-17.0. Related data shall be turned over to Technical Data Coordinator, in accordance with OSTI-LBNL-QIP-SIII.3, *Submittal and Incorporation of Data to the Technical Data Management System*, for entry into the Technical Database Management System (TDMS). Calibration status information should be provided to the M&TE Coordinator for updating of the M&TE database.

6. ACRONYMS AND DEFINITIONS

6.1 Acronyms

ASTM	American Society for Testing and Materials
DOE	Department of Energy
ESD	Earth Sciences Division
EH&S	Environmental Health and Safety
HT	Hydrogeological Testing
LBNL	Lawrence Berkeley National Laboratory
M&TE	Measuring and Test Equipment
NCR	Nonconformance Report
NIST	National Institute of Standards and Technology
OCR	Out of Calibration Report
OCRWM	Office of Civilian Radioactive Waste Management
OSTI	Office of Science and Technology and International
PI	Principal Investigator
QA	Quality Assurance
QARD	Quality Assurance Requirements and Description
QIP	Quality Implementing Procedure

QSL	Qualified Suppliers List
TDMS	Technical Data Management System
TIP	Technical Implementing Procedure

6.2 Definitions

Calibration: Comparison of a measurement standard or instrument of known accuracy with another standard or instrument to detect, correlate, report, or eliminate by adjustment, any variation in the accuracy of the instrument or equipment being compared.

Technical Implementing Procedure: Each TIP describes OSTI-LBNL technical tasks that (1) are repetitive, (2) are standardized, and (3) can return different results if deviation from the sequence of steps occurs.

7. REFERENCES

DOE/RW-0333P, *Quality Assurance Requirements and Description*

OSTI-LBNL-QIP-2.0, *Indoctrination and Training of Personnel*

OSTI-LBNL-QIP-5.0, *Preparing the Quality Assurance Plan and Quality/Technical Implementing Procedures*

OSTI-LBNL-QIP-6.0, *Controlled Documents*

OSTI-LBNL-QIP-12.0, *Control of Measuring and Test Equipment and Calibration Standards*

OSTI-LBNL-QIP-15.0, *Nonconformances*

OSTI-LBNL-QIP-17.0, *Records Management*

OSTI-LBNL-QIP-SIII.0, *Scientific Notebooks*

OSTI-LBNL-QIP-SIII.3, *Submittal and Incorporation of Data to the Technical Data Management System*

8. ATTACHMENTS

None

9. REVISION HISTORY

10/04/04 Revision 0, Modification 0:

Initial issue.

10. APPROVAL

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